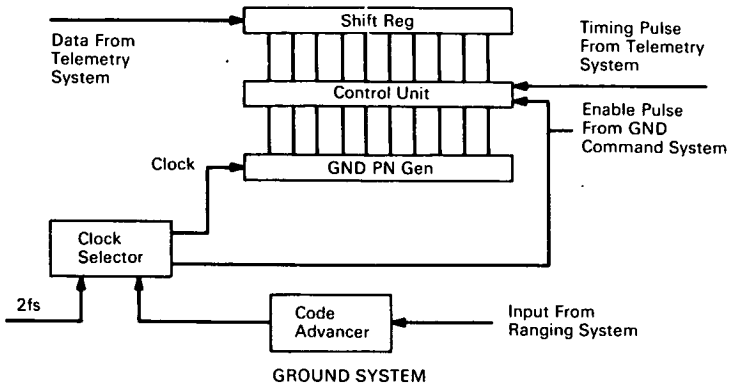
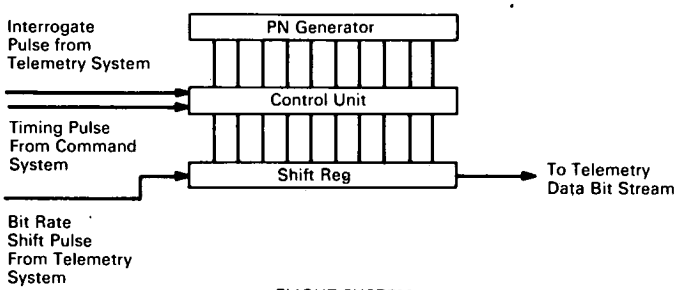
NASA TECH BRIEF

Design for a Rapid Automatic Sync Acquisition System



GROUND SYSTEM



FLIGHT SYSTEM

A design has been conceived for a system intended to provide rapid command sync acquisition between widely separated transmitter-receivers, such as between a spacecraft telemetry transmitter and a ground-based receiver. Use of the system in commercial satellite communications would facilitate rapid sync acquisition between stations and regaining of data lock after interruption or equipment failure. The system is based on a rapid, automatic range-adjustment approach rather than the time-consuming cycle slipping or stepping techniques of conventional phase-locked loops.

The basic scheme of the proposed system is that of a one-step adjustment of the ground PN code generator in order to make it synchronous with the flight PN generator. The state or phase of the flight PN generator is transmitted to Earth via the telemetry channel, and the status of the flight PN generator is detected by the ground system. This information is then used to set the ground PN generator. Assuming there were no delays in the telemetry processing and transmission time, the above process would cause synchronization between the two systems. Inasmuch

(continued overleaf)

as there is processing time and propagation time involved, these parameters must be accounted for. Once the ground PN generator is set by the telemetry information, it would be clocked rapidly by the code advancer to account for the delays. The code advancer, it should be noted, derives its data from the ranging system. Assume the total time elapsed between sampling of the flight PN generator and transmission of the ground PN code is T seconds. By multiplying T by the total number of symbols which appear in the PN sequence, the status of the flight command code generator can be predicted. Only the fractional second-portion of the delay time is used.

At the proper time in the telemetry bit stream, a pulse is initiated in the telemetry system which attempts to activate the control unit. The purpose of the control unit is to transfer the information from the flight command PN code generator into a shift register which will be clocked out in the telemetry bit stream at the bit rate. To prevent sampling of the flight PN generator during a transition time, a timing pulse from the command system is required, in addition to the interrogate pulse from the telemetry system to activate the control unit.

Lock is obtained by this sequence of events: The information from the telemetry bit stream is recovered and shifted into a register in the ground system. Upon completion of the input information, the coincidence of a timing pulse from the telemetry system and an enable pulse from the command system causes the ground control unit to set the ground PN generator. This action causes the ground code to represent the condition of the flight PN generator at the sample time. Since the flight code generator has changed status during the transmission and processing time, it is necessary to predict where the flight PN generator will be at the time of transmission to the spacecraft. This prediction must then be used to advance the ground PN generator. The function of the code advancer is to provide high frequency clock pulses to advance the ground generator to coincide with the flight generator. The number of pulses generated is dependent upon the total propagation and telemetry process time. The code advancer, it is proposed, will receive the propagation time information directly from the ranging system or through extrapolation. Since the code is repetitious at 1 bps multiples of 1 second are discarded; only the fractional portions of a second which represent the phase difference between the two codes are utilized.

The proposed system implementation will cause the spacecraft to receive a code which is in phase or very close to being in phase, depending upon the tolerances involved. To overcome some of the problems associated with the tolerances, the codes will be transmitted a fixed number of PN symbols out of phase. The two codes will then drift with respect to one another for a short period of time until lock is acquired.

Using a system such as this, it would not be unrealistic to achieve lock times in the order of a few seconds. In contrast with the present lock techniques, this number would be fixed. Present systems such as those used on Mariner '69 require anywhere from 0 second to 9 minutes to acquire lock.

Notes:

1. This Tech Brief formerly appeared as Brief-68-10428. Documentation is now available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10538

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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